DOCUMENT RESUME

ED 441 399 IR 020 301

AUTHOR	Robins, Jenny
TITLE	Teachers, Computer Networks, and the Internet at TechCity High.
PUB DATE	1999-10-10
NOTE	16p.
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Computer Networks; Educational Technology; High Schools; *Internet; Local Area Networks; School Surveys; *Teacher Attitudes; Teaching Methods
IDENTIFIERS	Access to Computers; Technology Integration; *Technology Role

ABSTRACT

Where other educational technologies like television, the VCR and the stand-alone computer have failed to have much of an impact in public schools, local school networks and the Internet have been succeeding. As of 1997, 89% of America's high schools were connected to a computer network. This paper presents a view of network technology from the perspective of teachers at TechCity High School. Despite massive technical difficulties, little training, and minimal recognition, these teachers are finding new ways to use computer networks in labs and in their classrooms. The teachers are finding that computer networks, compared to older technologies, are versatile and easy to use. Results of this multifaceted, ethnographic study document the impact that school computer networks and Internet access are having on teachers' professional environments and on their teaching methods. Questions for the technology plan blueprint is appended. (Contains 13 references.) (Author/AEF)

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Teachers, Computer Networks, and the Internet at TechCity High

By. Jenny Robins

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Oct 10, 1999

Teachers, Computer Networks, and the Internet at TechCity High[1]

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Abstract
Teachers are getting connected. Where other educational technologies like TV, the VCR and the stand-alone computer failed to make much impact in public schools, local school networks and the Internet succeed. As of 1997, 89% of America's high schools were connected to a computer network. This paper presents a view of network technology from the perspective of teachers at TechCity High School. Despite massive technical difficulties, little training, and minimal recognition, these teachers are finding new ways to use computer networks in labs and in their classrooms. Compared to older technologies, the teachers are finding that the computer networks are versatile and easy to use. Results of this multifaceted, ethnographic study of a single high school document the impact that school computer networks and Internet access are having on the teachers' professional environment and on their teaching methods.

1. Introduction

As of 1997, 89% of America's high schools had access to the Internet. Other technologies of this century, from the stereoscope to television to the VCR to personal computers, were predicted to change the classroom, but computer networks, with Internet access, are proving to be the innovation that delivers that promise (Richards, 1996). The most popular forms of media in the classroom are still chalkboards, lectures and textbooks (Proctor, 1996), but this might not be the case for much longer.

The purpose of my study at TechCity High School was to explore the path the "information highway" is taking through a public high school during the 1998/99 school year. In this paper I present my ethnographic study, examining how computer networks and the Internet are transforming a public school. Three techniques were used to gather data; participant-observations, a focus group meeting, and several face-to-face interviews. The advantage of employing participant-observation, as well as interviews in this study, is that it allows for the most natural setting to study teachers using networks in computer labs and in their classrooms. To illustrate, Worthen et al.(1997) offer a quote from "The flame Trees of Thika" by Elspeth Huxley:

> The best way to find things out... is not to ask questions at all. If you fire off a question, it is like firing of a gun - bang it goes, and everything takes flight and runs for shelter. But if you sit quite still and pretend not to be looking, all the little facts will come and peck round your feet, situations will venture forth from thickets, and intentions will creep out and sun

> themselves on a stone; and if you are very patient you will see and understand a great deal more than a man with a gun does. (Huxley p.272)

From the vantage of participant-observer I was able to conduct my research in the most unobtrusive way possible in order to present the perspectives of teachers who are early adopters of the networked technology at TechCity High.

1.1. Methods

1.1.1. The Setting

Tech City High School is located in a small city, geographically in mid-America. There is a large university nearby. The school building is in good repair. The school has 1500 students and 120 teachers. The ethnic mix of the students approximates the mix of the state as a whole. Students score above average on national standardized tests. TechCity High is not an experimental model school of any kind. However, it is in a university town and it is common for researchers from the university to conduct studies at the school.

Building security is tight with most doors locked from the outside during the school day. Halls are staffed with teachers acting as monitors, sitting at desks in every hallway. In my visits at the school I did not witness a single case of confrontation between students or between students and staff. I describe the environment as orderly.

The high school has over 250 computers. It has a "communication center," which is a computer lab that all the departments in the school can share. The business department has three additional computer labs. There is a social studies media room arranged like a small movie theater with a large screen, an LCD projector, and a computer system where CD's and web sites can be used in instruction. The library offers site and community access to several article databases, including full text databases. There are computers in the library and at least one in every classroom. All the computers in the building are wired into a local area network. There is a high bandwidth, T1 phone line that provides Internet access in every classroom. The majority of the equipment and the local area network were installed less than two years ago. The T1 line was installed six months before my study. The school district supplies provides one computer technician, half time. He is responsible for maintaining all the schools' computer, network hardware and the schools' network servers.

Students are given training in order to use the network and must acquire written parental consent before they can log on to the Internet. Lab supervisors can monitor all Internet activities. Privileges are secured through use of Network IDs. Infraction results in a loss of Internet privileges but not lab privileges. The lab in the communications center opens at 7:30 and closes at 4:30 for students. During the last period of the day, the lab is usually reserved for unstructured student use.

1.1.2. The Respondents

The respondents in my study were members of the TechCity High's technology committee. The committee has met regularly for over two years. It has a core membership which includes about a dozen teachers, the school librarian, and the

communication center administrator. The committee has an informal membership policy where the participation of all teachers is encouraged. Teaching experience among the core group varies from the first-year teacher to the twenty-year veteran. I overheard three of the teachers say they have presented papers, or will present papers at conferences in their discipline area. The committee's chief responsibility, during the year of my study, was to create a technology blueprint to be incorporated into districts' three-year technology plan as directed by the state board of education. I was able to become a member of the technology committee as a representative from the outside community. I explained to the respondents that I was a doctoral student from the university gathering data on how teachers get the information and resources they need to do their jobs.

1.1.3. Gathering Data

I selected TechCity High School because it provided an opportunity to observe teachers using the school network and the Internet. For 5 months in the Fall of 1998, I conducted research as a participant/observer at TechCity High School. I visited the school an average of twice a week for two and half hours a visit. I tried to schedule my time to coincide with faculty meetings, department meetings, and technology committee meetings. After each visit I wrote field notes. In total, I spent approximately 60 hours at the school during this period.

Near the end of my participant-observation, I led a focus group meeting with five teachers who were fellow members of the technology committee. During that meeting, a set of questions were developed. See Appendix A for this question set. I used these questions to direct my interviews in the second half of this study. In addition, teachers' responses to these questions were integrated into TechCity High's technology plan which, in turn, was submitted to the school district. In this phase of my study, I conducted seven interviews and a half a dozen more observations, spending an additional 25 hours at the school.

Interactions involving students are not reported, as these are beyond the scope of this study.

1.2. Research Questions

> Teachers will use technological innovations, but only if, given the constraints of the environment, those technologies show themselves to be efficient, effective ways to address the demands of the job. The innovations most widely adopted have been those requiring the fewest adjustments or creating the fewest problems, fitting most easily with the existing structure and yielding the greatest benefits for the tasks at hand. (Gormly, 1996, p. 277)

The popular press still portrays teachers as intransigent Luddites "intimidated by technology" (Kantrowitz,1999), but Gormley states that it is pragmatism, not fear, that keeps teachers from adopting technology. Now that most high schools in America have Internet access and many have local networks, it is possible to test Gormley's assertion in

relation to these technologies. But first, I needed to discover what the constraints are in the teachers' professional environment at TechCity High. Who are the players in the teachers' work world, and what kinds of pressures do they exert on teachers? Complementary to this, I wanted to learn about teachers' inner motivations. This leads to a second research question; what are the operational goals of the teachers themselves? Specifically, what criteria do teachers use to measure success in their jobs? Next, I wanted to learn how the teachers are using networked resources for teaching today. The schools might have Internet access, but are the teachers adopting the technology? If so, is it because these technologies lead to more efficient and effective teaching methods? In return, there is a fourth path of inquiry. What is the impact of these technologies on the teachers' methods, on their goals, and on their professional environment? This paper is a summary of my findings in each of these areas. It offers a multi-directional view of the route the Information Highway is taking at TechCity High School

2. The Professional Environment at TechCity High

The professionalism of teachers is mediated by their environment, which places constraints on their activity. The hierarchy at the school is rigid and shallow. Teachers are answerable to the principal who is in turn answerable to the school district. The principal mediates between the parents, the district and the teachers. The one hundred plus teachers at TechCity High have little personal interaction with the Principal. The only teacher I observed talking with the Principal during my study was the union steward [1F01][2]. Twice a year the principal addresses a meeting of the full faculty. At the meeting that occurred during my study, she praised each of the departments, but did not single out individual teachers for recognition [1F06].

Parents exercise authority over the teachers in that they can take complaints directly to the principal or the school district. At parent-teacher conferences, I observed that the female teachers dressed well and wore makeup. The male teachers put on suits and ties. This did not occur at any other time during my study. At a meeting with the school district's technology specialist, for example, his business attire made him stand out in a room with eight teachers [1F12].

The local school district has the authority to impose edicts on the teachers concerning both curriculum and technology use. These edicts usually come from the state board of education. However, only one of the teachers I observed and interviewed used the state curriculum guidelines in his discipline. One veteran teacher remarked that he felt that the state and teachers were out of touch with each other: "...there is a great gulf between administration and teachers everywhere. ... Both sides are at fault and both sides are trying to do their best. " [JM].

Other players in the organizational hierarchy include the district computer technician who did not hesitate to admit that if teachers are not respectful, their computers will not get fixed [2F03]. According to a union agreement, hardware problems must be fixed by the district technician. The district technology specialist explained the order of repairs for the district's computers: at the top of the list are the office computers. This is because the state demands record keeping on school attendance be submitted daily. Second priority

are computer labs. However, only the communications center lab computers is actually given priority at TechCity High. The three labs in the business department are given the lower priority consistent with classroom computers. One of the teachers pointed out that by not keeping classroom computers running, the district was not "attending to where it effects the greatest number of people" [1F12].

Textbook vendors are outside the organizational hierarchy of the school, but are part of the teachers' work world. One year in seven is referred to as an "adoption year," when department heads at TechCity High are permitted to submit a textbook order to the school administration for approval. Money allocated for textbooks can not be spent in other ways. There is no comparable budget for other materials. I was an observer at one ordering session. The vendor from Glencoe/McGraw Hill met with teachers in the business department. He discussed his wares and left an order form, which the department head later completed and submitted to the school administrators [1F19]. The administrators returned the order to the department because it was 233% over budget [2F03].

Teachers spend eight hours a day at TechCity High. The day is broken into seven periods. Five periods are spent teaching in the classroom. One period is spent on hall duty. Each hall has a student desk, which serves as a station for the teacher who is the acting hall monitor. Teachers can use that 50 minutes to grade papers. One period a day is a "free" period, during which time students can meet with teachers. Teachers can also use this "free" period to prepare for class. They typically have 20 minutes for lunch. Class preparation and grading that can not be done during hall duty or the free period must be done at home. I heard several teachers refer to the time they spend at school as "contact time," meaning that they are to be available to meet the needs of students all day, every day. As TC described; "It's not like you can come in, have coffee, put your feet up, and say 'I don't feel like working today'." [1F15]

The elements of the school environment outlined above describe constraints that impact the work world of teachers. It is difficult to fit their work into an eight-hour day. Their budgets are non-discretionary and limited. They have little control over the repair of their equipment. They must operate under the guidance of an administration where the information flow is inadequate. They are vulnerable to criticism from the parents of disgruntled students, and there is no avenue of recognition for their efforts. After discovering the forces that exert pressure on teachers, it is not surprising that only 50% of teachers remain in the profession over ten years (Marso and Pigge, 1997). Yet, the teachers rarely discussed workplace issues such as these. However, I wonder if a poster on the wall in one of the business labs is a subtle complaint. It reads:

> In no environment should the desire to centrally manage systems be more important than giving users the right tools for their jobs. [1F01]

3. Teachers at TechCity High Define Success

The next area of my inquiry concerned the teachers' goals. I was interested in discovering the actual goals of teachers rather than their spoken, idealized goals. This study provided

an opportunity to observe how teachers prioritize their activities. For example, the teachers energetically implement the school policy of putting the students first. I observed a teacher vacating his station in the communications center in order to provide a place for a student[1F05]. On several occasions teachers dropped their conversations with me and with each other to attend to a student with a question. I attended a departmental meeting with a textbook vendor that was interrupted because the department head left to help a student. Moreover, individual students seem to be the most popular topic of conversation between teachers [1F03, 1F05]. For example, in the teachers' lounge, I observed two teachers, who were new acquaintances, use their familiarity with individual students to discover their common ground. They took turns mentioning students' names until they came to one they both knew, then shared their opinions about that student [1F04].

Initially, I understood the policy of "putting students first" to be simply a professional concern, but I later found this assessment was incomplete. The interviews in the second part of my study filled in the picture. One teacher spoke repeatedly about the need 'to seize that teachable moment when the students are asking me a question' [1F15]. Another teacher talked about success in terms of being prepared for the 'serendipitous moment' [2F05] when a student is motivated to pursue an inquiry . Chen, et al.(1997) describe this as "the point of intellectual purchase" (p. 665). Based on my observations and interviews, I believe this is the way teachers measure their success, by their ability to orchestrate these occasions and by their readiness to provide a learning opportunity at the precise moment that a student expresses an interest. In conclusion, I wonder if what the teachers see, when they think about their work, is the face of a student looking back at them. As TC described:

> ...when you're at school it's contact time ...teachers have to have something ready for contact, every day, every hour. [1F15]

4. Adoption of the the School Network and the Internet at TechCity High

The overriding focus of this study is how teachers get the information and resources they need to do their jobs. In keeping with this, I was interested in how the teachers were using their local network and the Internet to get resources for teaching. The school network became operational a year before I began my study. The high bandwidth connection to the Internet was less than six months old. The teachers have not received any formal training and the network is plagued by technical problems.

In a sense, the teachers in the technology committee at TechCity High are cyber pioneers. The terrain they are crossing is rough. During my study, the email service worked intermittently. The new library automation system preventing students from checking out materials [1F02]. Caching problems on the server often interfered with Internet access [1F05]. In addition, individual classrooms do not have printers. Two printers in the Business Department labs were out of service during the entire period of this study [1F02; 1F05; 1F09; 1F010; 1F12; 1F15]. Repeatedly, files saved by students could not be retrieved [1F09]. It took months to discover the problem was with the server, not the students or the teachers [1F02]. I witnessed this problem consuming an entire class period

[1F09]. Teachers had to plan redundant lessons, because they couldn't count on the system being able to deliver the planned curriculum [1F10]. The district technology specialist was sympathetic but explained that, in the district, there is only 1 technician for 700 computers, a situation he described as "insane" [1F12].

Teachers are also pioneering in that they face unknown outcomes. In the state where TechCity High is located, there are currently no curriculum guidelines for teaching with network technology. In spite of this, the teachers on the technology committee are leaving a trail for other teachers at the school. JM explained that four years ago only 20% of the teachers at the school used technology; 60% used it at the time of my study [2T03]. A survey administered by the local school district confirms JM's statement [TC8]. This exponential increase occurred despite the technical problems teachers had to cope with and despite a lack of teacher training. Computers have been available in schools since the early 1980's, but as of 1994 less that 20% of the teachers in the district used them. The sharp growth in use coincides with access to the Internet and the installation of the school's local network.

Though the growth curve is sharp, the way network technology has been adopted follows the classic pattern of diffusion defined by Everett Rogers (1995). According to Rogers, adoption of an innovation is influenced by five characteristics:

1. Relative advantage -The degree to which an innovation is perceived as better than the idea it supersedes.
2. Compatibility -The degree to which an innovation is perceived as being consistent with existing values, past experiences, and the needs of potential adopters.
3. Complexity -The degree to which an innovation is perceived as difficult to understand and use.
4. Trialability -The degree to which an innovation may be experimented with on a limited basis.
5. Observability -The degree to which the results of an innovation are visible to others..

The fast pace of adoption, in the face of severe technical problems and unknown outcomes, suggests that powerful forces are in play at TechCity High School. Interviews with teachers provide illustrations of how the relative strength of each of Roger's characteristics reflect the way network technology is used at TechCity High.

1. Relative advantages –Several teachers stated that using the Internet "opens up the world" for the students. It allows them to "build real projects": "They are getting to do things they normally couldn't do. A book is a good thing and it has certain information but you can't get that interactive stuff..." [PA2]. The network also makes it easier for teachers to get to the materials they need for classroom instruction. "If I have it in a computer, all I've got to do is pop it up and there it is instantaneously" [NE1].

> ...anything that can be done with text can be done better with a computer because you have the opportunity to correct it more readily, to make it more colorful and interesting, to back it up and to make multiple copies, and to spell check it and grammar check it. Most important you can go to the sources of the information. [JM]

2. Compatibility - According to EN, teachers want students to become self-directed learners, and technology is often the "bait" to make them "recognize the need to improve themselves. ...that's just another specific of how technology lends itself to both the enticement and efficacy of teaching" [EN1]. Teachers also look for resources that can help them at precisely the moment of student inquiry [1F15]. Unlike television and stand alone computers, networked information technology is there, supplying resources, when the teachers need them, as in CJ's example:

> I took them to the CNN site... It was really a serendipitous moment to talk about thinking critically...

3. Complexity - In the last 10 years, graphic user interfaces have improved to make computer use easier. At the same time, the population has become more computer literature. Both work to the advantage of teachers using the network. For example, orientation in the communication center used to take three days, now it takes 20 minutes [PA1].

   EN found networked technology 'so easy that it is seductive.' When he tried to integrate it into his lessons, he felt it lured him to a deeper level of involvement. Giving voice to that seduction he relates his experience:

> It kind of whispers in your ear and says, "Now...this wasn't so hard was it? You can do this. And guess what, if you think this is cool, wait until you take a look at this"[EN1].

4. Trialability - The Internet has an enormous amount of free resources for students. Unfortunately, there are also a number of sites that are not suitable for students, or that have only entertainment value. "It was like a candy store to be out on the Net" [PA2]. Teaching time has been lost, but teachers soon learned to integrate the Internet into their curriculum in innovative ways. For example:
   - An English class researched the 1920s for a unit on F. Scott Fitzgerald's "The Great Gatsby"
   - Students in Consumer Economics followed the Stock Market on the Good News Bears web site
   - Foreign language students created travel brochures using materials they found on the Internet
   - In General Science class, students found material about the Periodic Table on the Internet

- In Chemistry, students access the ChemVis site at the National Center for Super Computer Applications (NCSA)

In addition to Internet resources, teachers and students also have access to applications that are freely available over the network. Standard applications like Microsoft Word, PowerPoint, FilemakerPro, and Claris Homepage can be used in classrooms and in labs. Making applications available from the server proved so convenient that teachers have asked to install their CDROM based applications on the network. In many cases licensing agreements prevent this [PA2]. Still, having resources readily available has played an important role in allowing teachers to experiment with the new technology.

5. Observability - The more the pioneering teachers use it, the more other teachers become interested. The network was the first topic on the agenda during the meeting of the full faculty [1F06], and the TechCity High communication center is a busy place, accommodating teachers who want their classes to use network and Internet resources. Every month last year, in the communication center, there was a 100% increase in use over the month before [PA2]. There are between 1300 and 2000 student sessions in the lab per month now. As the center administrator explained in April [PA2]:

> It's not easy to get in. You have to plan ahead. Right now I am pretty much scheduled through the end of the year.

By comparison, classroom computers have less visibility. For example, it is difficult for teachers to visit each others' classrooms due to limited free time. When teachers come to book their class in the communication center, the administrator can share examples of ways teachers use the network. There is no one with a comparable role who can share ideas about classroom use. Yet at the focus group meeting, several teachers mentioned a desire for classroom LCD projectors so their students could view computer displays [1F15]. This indicates to me that the teachers have ideas about how to use their classroom computers, but still lack the necessary equipment to implement new activities.

5. How Computer Networks Impact Teaching at TechCity High

As the experience of the last two decades demonstrates, the introduction of computers by themselves was not enough to revolutionize the classroom (Procter, 1996). However, as the rapid growth in computer usage today attests, school computer networks are having a dramatic affect at TechCity High. Networked instructional technologies not only fit within the traditional school structure, as described in the last section, they open up byways to new types of classrooms. It is not just a case of continuing the same practices in a new way. The pioneering teachers at TechCity High are transforming both the context and the content of teaching. From the data, I have identified five separate transitions at TechCity High School stemming from network use. The teachers' professional culture is changing in two areas, and teaching methods are being impacted in three areas.

5.1. Context - Changes in the professional culture at TechCity High

5.1.1.The top down management structure is becoming less rigid:

The power structure at TechCity High is showing signs of change. For example, in the past teachers had no informal way to exchange information with the Principal. If a teacher had a matter to discuss, it meant scheduling a meeting, as neither the teacher nor the Principal have free time in their daily schedule, and serendipitous face-to-face meetings are rare. E-mail has opened a non-obtrusive avenue for interaction. During the initial part of my study, the email server did not work. Soon after it became functional, I noticed a teacher use it to broach a delicate issue, concerning staffing, with the Principal. She said she has been sending emails that read, "Are you aware..." to which the Principal had been replying with thanks [2F03]. Nothing analogous to this polite, explicit, informal exchange was possible before the network was operational.

Teachers are also becoming aware that they need support and stimulation, not direction from administrators. In the 1980's and early 90's, administrators tried repeatedly to get teachers to learn basic computer skills. Now many teachers at TechCity High are proficient computer users. As a result, they have definite ideas about the type of training they would like from the district. As JM remarked:

> The thing is an administrator can't tell someone what to do. An administrator has to facilitate people developing on their own. ... What people need is some support and stimulation. It they have a good idea [the administration] should say "Yes. We'll help you with that some way."

5.1.2. Teachers are creating their own teaching materials:

Textbooks are being used less frequently at TechCity High. A typical textbook today is large and likely to weigh more than six pounds [1F19]. Carrying several books back and forth from home to school is difficult for students. Textbooks can also become out of date before the next "adoption year." Since the network can deliver small chunks of up-to-date curriculum, there is "a legitimate question as to whether the money spent is better spent in textbooks versus another delivery system such as projection [EN2]". TS, a teacher in the business department, said he only used the textbooks for 3 or 4 lessons a year [2F03].

In keeping with the spirit of disintermediation on the Internet (Peng, 1999), teachers are reacting by designing their own instructional resources rather going through vendors:

- An English teacher is having a student create notes for the class that are then made available to other students over the network
- An English class created a web based survey on the American Dream
- A history teacher is creating a video slide show on World War II
- A business teacher created a word processing document covering what students need to know about job interviews
- A grammar teacher is creating a database of cartoons he can use to illustrate literary terms and concepts

- A chemistry teacher is submitting his lesson plans to ChemVis at the NCSA to be shared with other teachers over the Internet

Meanwhile, the salesman from Glencoe/McGraw-Hill knew of no plans to make network based curricula available.

5.2. Content - Changes in teaching methods at TechCity High

5.2.1.Words are no longer the only teaching tool:

Reading textbooks and listening to lectures are not the only paths to learning. An English teacher finds students "...have an automatic affinity for visual" [EN1]. I observed students at TechCity High turning in class assignments made with PowerPoint slides where pictures told as much of the story as the text [1F03]. Students could enroll in the school's Intranet WebSite class which is an similar to the traditional Newspaper class. There, using HTML, they were learning to demonstrate associations between ideas using hypertext as well as words [2F01]. In the class that developed a web-based survey, students discussed how to analyze the survey results [CJ]. This required students to analyze the emailed responses to find associations. In each of these examples, students learned though activities that were not based solely on listening, reading and writing. Moreover, students learned skills that are valuable in college and in today's job market.

5.2.2. Technology & curriculum are becoming inseparable in the information age:

The "Great Media Debate," over whether students actually learn from computers or if computers are merely a medium to deliver instruction (Clark, 1994; Kozma, 1994), might soon be re-ignited as new uses for the school network and the Internet make it impossible to separate information technology and instruction. For example, devising search strategies is often a key component in learning and problem solving today:

> Part of the effectiveness of using the Internet is the ability to use key words effectively. So [the students] need to first of all narrow the focus of their inquiry and then select, through pre-search, effective key words and use those key words to try to locate a good source. [EN2]

Using materials found on the web also opens a dialog in critical thinking, as students must learn how to discern and defend the credibility of the materials they use [EN2]. While students were involved in similar activities before the Internet arrived in the classroom, at TechCity High this type of activity is becoming more common as teachers seize the moment of student inquiry to direct students to web sites of resources, search engines, or journal databases [PA2; 1F04].

5.2.3.The roles of teacher and student are becoming less distinct:

The roles of teacher and student are becoming a little less distinct as the classroom becomes a community of learners. As increasing numbers of students have computers and network access at home, they are taking learning out of the classroom [EN1]. This often results in the pooling of knowledge within the classroom, with teachers becoming a member of the classroom community, not just the "sage on the stage." When teachers

learn from students, and students learn from each other, the culture of the classroom is affected. As a result, EN believes students take more responsibility for their education:

> So taking ownership to me is returning to the natural state of inquisitiveness and to recognize that we are, in this information age, empowered to find out the answers to our own questions. We don't have to depend upon any particular person [EN1].

The volume of information available to students over the Internet is beyond the ability of a single teacher to master, as are the number of activities that can be done with a networked computer. Rather than feign knowledge, or to confine students' access to information to that which a teacher has mastered, students and teachers work together to solve learning problems. CJ's favorite classroom question is "Well, what can we do?" Students are then given reign to direct the learning activity. Even in the communications center, the administrator occasionally needs to ask students, "'Does anybody know how to...?' and then the kids will help." [PA1.2].

6. Discussion

The findings of this study describe the context of the professional environment of TechCity High, the teachers' active goals, the diffusion of networked technology, and the impact of the computer networks and the Internet on teachers. The results of this study might best be considered a presentation of contextually anchored facts to be used to suggest questions for future research (Worthen, et al., 1997). Technology use at TechCity High is representative of use in only the most fortunate high schools in America today. The data herein does not, in itself, predict a general trend, yet it does lead to a number of suppositions about what might happen in high schools in the next decade.

The rapid growth in computer use despite "insane" technical problems is impressive, but alone, it is not enough to explain the changes I observed taking place at TechCity High. Nor is the variety of uses teachers have found for the school's network and the Internet a sufficient explanation. Rather, it is the force of the cumulative changes that are bringing about a transformation at the school. The impacts of networked technology on teaching, as discussed in the last section, converge at this point; the artificial structure of the public high school, the separation between the school and real life, is dissolving as the information highway brings the outside world into the classroom. If similar changes are taking place at other high schools, they are likely to effect the entire educational support industry, from colleges of education, to school boards, to vendors of products for teachers. Education colleges will need to train teachers to use technology to support student inquiry. Teachers at TechCity High are orchestrating instruction, not delivering curriculum. The hierarchical organization whereby school administrations attempt to direct teacher activity will need to yield, as teachers, empowered by tools that enable them to more effectively do their job, start demanding specific supports. The textbook industries will need to move from serving up large, glossy textbooks toward bite size, down-loadable slices of content. If they do not, teachers are likely to create their own curriculum resources, as the examples in section 5.1 attest. Since John Dewey wrote in 1938, educators have searched for ways to link education in the classrooms with real life,

"...education of, by and for experience". From this modest study, there are indications that a reformation is occurring from within at TechCity High.

Notes:
1. Pseudonym
2. Citations in square brackets point to specific field notes and interview transcripts.

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Appendix A: Questions for the Technology Plan Blueprint

The state board of education is requiring each school district to submit a Technology Plan to the state in order to be eligible for state and federal technology grants.

The district is asking each school in the district to complete a template developed to demonstrate the districts' current status according to the state guidelines. In order to provide accurate data to the district, the technology committee would like you to answering the following questions for your department.

Please make as many copies of this form as you need. Please feel free to attach extra sheets if more room is needed.

1. How do you use technology for instruction?
2. How do you use technology to meet state curriculum guidelines?
3. If more money were available for technology, how would you use it?
4. What frustrates you about using the technology?
5. If the older MACs in the building were made available, how would you use them?
6. What types of technology would you like to have?

Lap Top Computers _____	MACs_____	PCs _____
LCD projectors _____	Digital cameras_____	VCRs _____
CD Players _____	Video cameras _____	TVs _____

7. Does anyone in your department have unique funding sources associated with technology use?
8. Who do you ask when you have a question about using or doing something with the computer?